THE DIETETIC USE OF PREDIGESTED LEGUME FLOUR, PARTICULARLY IN ATROPHIC INFANTS:

WITH A STUDY OF ABSORPTION AND METABOLISM.[1]

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Beans and other legumes have throughout many years past been occasionally recommended as useful in dieting infants, and in Germany especially they are said to be a constituent of a number of preparations of "Kindermehl." So far as we know, however, they have been given in a form in which it is impossible for even adults to take considerable amounts without tending to cause more or less digestive disturbance, particularly if they are given for some time; and statements concerning their effects in infants have been based almost entirely upon somewhat loose and casual observations of clinicians or upon the so-called experience of the laity.

The work that we are reporting was carried out partly in order to determine the possibility, in infants that have persistent difficulty in digesting milk proteids, of administering a useful quantity of vegetable proteid in a form suited to their digestion. We also investigated the question whether this proteid in its influence upon metabolism shows any important differences from milk proteids that are dependent upon the character of the proteid as distinguished from its digestibility and from the mere fact that it is proteid food.

Our results have shown the feasibility of successfully administering vegetable proteid to infants in considerable amounts and for at least a fairly long period. They also suggest that the favorable influence upon nutrition observed in a large proportion of cases is more largely referable to the character of the proteid that we used than to the amount, though this is a point that necessarily has in it an element of undemonstrable theory, and that can be provisionally accepted only after further control studies.

The investigation of the use of vegetable proteid in infants was undertaken at the suggestion of Dr. J. P. Crozer Griffith. The coincident consideration of the probable dependence of the nutritional improvement that occurred in a large proportion of the cases studied, upon the character of the proteid, we based upon the following theoretical grounds: Native food proteids are of various kinds, the chief among them being albumin, nucleoalbumin, nucleoproteid, and a less important group most satisfactorily called albuminoids. Albumins, represented for example by egg-albumen, are distinguished by a series of reactions, but, for our purposes, particularly by the fact that they do not contain phosphorus compounds. Nucleoalbumins, conspicuously represented by casein, are especially distinguished by the fact that they contain phosphorus compounds, but do not yield any xanthin bases upon disintegration. Nucleoproteids, represented among animal foods most strikingly by various organs rich in cells, such as the pancreas and the thymus, but found also widespread in the vegetable kingdom, are distinguished chiefly by the fact that they contain a large amount of phosphorus compounds and do yield xanthin bases upon their disintegration. The albuminoids are represented by gelatins and a series of other substances which are of less specialized form than the substances mentioned above.

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[1] Read by invitation before the Buffalo Academy of Medicine, December 13, 1904.

In human or other animal tissues the protoplasm of the cells is made up largely of albumin, in some cases of nucleoalbumins also; while the nuclei of the cells are formed chiefly of nucleoproteid. Adults receive in their food, in addition to albumin and nucleoalbumin, considerable quantities of nucleoproteid. It is not known how they manufacture the nucleoproteid of their tissues, but it is at least not improbable that the nucleoproteid of the food, or at any rate the nucleic acid that this nucleoproteid contains, is used for a part or the whole of this process. This would at any rate appear to be an economical method as compared with the wholly synthetic manufacture of nucleoproteid from relatively simple substances. In infants, however, the cell nucleoproteid must be manufactured, for the food contains no true nuclein, the proteids of the milk being entirely albumins and nucleoalbumins. If, then, the adult uses his nucleoproteid more or less directly in cell construction, the infant has in this point greater complexity in its metabolism than the adult; and it is possible that this is one reason that the assimilative powers of an infant are so much more subject to uncontrollable breakdown than those of an adult. It seemed possible, therefore, that when the assimilative functions are already incompetent it might be feasible to help the child by giving it nuclein in a form that would be readily absorbed without disturbing the digestion. The difficulties in the way of using animal foods for this purpose in noteworthy amounts are too great, but vegetables of the class of the legumes (beans, peas, lentils) contain extremely large amounts of nitrogenous substances and among these there is a considerable amount of nucleins. That starch can be given to infants in large amounts if predigested is known, and this fact has been used in a special manner by Keller, for example, with apparently very successful results. There was, therefore, no evident obstacle in the way of the use of legume flour except the possibility that the proteid that it contains might disturb the digestion. Heating, however, causes much of this proteid to go into solution if it is finely ground, and, from a mechanical standpoint, the remainder would appear to be at least no more disturbing than the easily coagulated milk proteid. The practical effects of its use remained to be determined.

In studying this question we have given predigested bean flour to a series of infants, having first convinced ourselves, by the administration of small amounts of the bean flour, that it did not disturb digestion, and having also first studied its absorption and determined that this was, in the infants investigated, satisfactory.

We will discuss first the method of preparing the flour and the manner in which it was used, and then refer briefly to the studies of absorption and metabolism, subsequently discussing the clinical results.

We were unable to find on the market any satisfactory bean flour or pea flour. We, therefore, secured white kidney beans, dried them, and in our first experiments ground a few pounds of flour ourselves in an ordinary spice mill, removing the shell, and using only very fine flour secured by bolting; subsequently we had about two hundred pounds ground for us. It is essential that the flour should be finely ground in order that it may be subject to satisfactory predigestion, and also in order that the proteid may be properly absorbed. There has been much discussion of the question whether vegetable proteid is well absorbed or not (in adults). It seems probable that the correct answer to this question is that unfavorable results are due to the form in which the vegetable proteid is administered. The studies have usually been made with vegetables cooked in the ordinary manner, and in this form the proteid is enclosed in large part in a tough mass of cellulose. Rockwood has shown that, if administered free from cellulose, vegetable proteid is well absorbed. It is, therefore, important to see that the flour is finely ground. The object of predigestion was, of course, to convert the starch, the method of preparation having no effect upon the proteid excepting that due to the heat. In our work we usually prepare a 10 per cent. solution of predigested bean flour, first mixing the weighed or measured bean flour with water until made into a smooth paste, then adding more water until it can be easily stirred, and then heating in a double boiler at a good heat for fifteen or twenty minutes, stirring very frequently. During this time the flour of course swells and a 10 per cent. mixture of flour and water becomes a rather thick paste. It is then cooled to between 60° and 70° C., and the ferment is added and allowed to act for about ten minutes, stirring the mass frequently and loosening the portions that have adhered closely to the sides of the vessel so that they may undergo thorough digestion. Within a few moments after adding an active diastatic ferment the mass becomes perfectly fluid and resembles a rather thin soup. After this, in order to stop the action of the ferment, it is brought to the boiling point; it is then cooled and is ready for use. The ferment that is to be used is largely a matter of choice, the only essential being that the ferment shall be active and in convenient form. We generally used cereo, sometimes maltine. Any of the other good diastatic ferments on the market would probably do as well. We have used the first mentioned chiefly because it is in very convenient form for this individual purpose and is very active. The nature of the mixture after the digestive process is past has not been investigated farther than to determine that there is little, if any, iodine-reacting starch present and that practically all the flour is in a fluid form. The proteid present would seem from the physical standpoint to be in a condition very suitable for absorption, for it is largely in solution, the solid particles that remain are few and extremely small, and it is impossible to bring down any coagulum by heating, while even strong acids precipitate the proteid only in the form of fine flakes.

In using this preparation with infants we have done as follows: A quantity of the infant's milk mixture approximately equal in food value to the amount of bean flour that we were about to add was discarded and was replaced by 10 per cent. solution of bean flour. For example, with a 3.6.1 milk mixture, the 10 per cent. bean flour is somewhat less than a direct equivalent of an equal quantity of the milk mixture; therefore, in such a case we gave the food as follows: if the child was receiving 48 oz. of 3.6.1. per day this was reduced to 36 oz., and 15 oz. of 10 per cent. bean-flour solution was added; the child therefore got 51 oz. a day, but received about the same energy value (actually slightly less) in its food. In a good deal of the work bean flour was not added at one time to the total quantity of the day's food, but was kept separate and a proper amount was added to each feeding. For example, with previous feedings of 4 oz. of 3.6.1. mixture the child was now given 3 oz. of 3.6.1. and 1¼ oz. of 10 per cent. bean-flour solution. In almost all our work with infants the feedings contained 2.5 per cent. to 3 per cent., at most, of bean flour. From the determinations that we made of the nitrogen in the flour, which will be mentioned immediately, we found that 3 per cent. of bean flour meant about 0.65 per cent. of proteid.

We made, in all, five analyses of the nitrogen in the bean flour. They resulted as follows: I., 3.447 per cent.; II., 3.448 per cent.; III., 3.394 per cent.; IV., 3.559 per cent.; V., 3.327 per cent.; the average being 3.435 per cent. of nitrogen, or 21.468 per cent. of proteid.

In our absorption work we used diapers made of rubber tissue, large wads of absorbent cotton being placed over the genitals to avoid any mixture of the urine with the feces. By this method we could collect the feces on the rubber diapers with entire success and without loss. The only difficulty that we had was that in one instance, when the observations were continued for ten days, the child had rather marked irritation of the skin about the buttocks.

In the one instance in which we did a complete nitrogen metabolism experiment in an infant, we collected the urine by introducing the penis into a piece of rubber tubing, strapping the tubing on with adhesive plaster, the lower end of the tubing discharging into a vessel which collected the urine. In the metabolism experiment in an adult we followed the customary methods. In the case of the infants the nitrogen in the food was determined each day. In the experiment with the adult we used a diet containing substances of which we had many times estimated the nitrogen-content ourselves, or which have a well-known and practically constant nitrogen-content.

The results of our absorption experiments in infants were as follows: Case I. was a boy, aged six months when studied, who had been in the house three weeks, and in this time had gained and lost repeatedly an ounce or two at a time. When the study was begun he weighed six pounds fifteen ounces. He had usually three soft bowel movements daily that were fairly satisfactory. In the preliminary period of study the child received 4 oz. of 4.7.2. mixture every three hours. This period of study was three days in length. The child was then put on 3 oz. of 4.7.2. mixture and 1¼ oz. of 10 per cent. bean-flour solution every three hours, and the absorption was studied for a period of six days following. In the two periods the conditions of nitrogen absorption were as follows:

Preliminary Period.		Bean-flour Period.	
Received in three days	8.601 gm.	Received in six days	19.111 gm.
Average daily	2.867 “	Average daily	3.185 “
Excreted in feces in three days	0.503 “	Excreted in feces in six days	1.203 “
Average daily	0.167 “	Average daily	0.200 “
Absorption in three days	8.098 “	Absorption in six days	17.908 “
Average daily	2.699 “	Average daily	2.984 “
Absorption of the intake	94.2 %	Absorption of the intake	93.7 %

The second case was studied at the same time and in the same way. The same amounts of food were given in both periods, but the child vomited about two ounces after one feeding; therefore, the intake in the preliminary period was slightly less than in the first case. This child was four months old when studied; had been in the house six weeks, and had varied between six pounds thirteen and one-half ounces and seven pounds three ounces, and showed the latter weight when the bean flour was begun. There were three or four bowel movements daily, which were yellow, quite well digested, but contained a little mucus. The conditions of nitrogen absorption in this case were as follows:

Preliminary Period.		Bean-flour Period.	
Received in three days	8.422 gm.	Received in six days	19.111 gm.
Average daily	2.807 “	Average daily	3.185 “
Excreted in feces in three days	0.415 “	Excreted in feces in six days	0.548 “
Average daily	0.138 “	Average daily	0.091 “
Absorption in three days	8.007 “	Absorption in six days	18.563 “
Average daily	2.667 “	Average daily	3.093 “
Absorption of the intake	95.1 %	Absorption of the intake	97.2 %

In these two cases the absorption was very good in both periods. In the first case there was only a fraction of 1 per cent. difference in the two periods; in the second case absorption during the bean-flour period was better than during the preliminary period. These figures show that in these children the bean proteid was fully as well absorbed as the milk proteid, and both were extremely well absorbed.

In another child we investigated both absorption and metabolism while bean flour was being given. We had no opportunity to study a control period when the child was taking only milk. The figures for the period of investigation, which was five days in length, are as follows:

Received of nitrogen in five days	14.430 gm.
Average daily	2.886 “
Excreted in feces in five days	1.844 “
Average daily	0.368 “
Absorption in five days	12.586 “
Average daily	2.517 “
Absorption of the intake was therefore	87.92 %

This child's urine was studied daily, with the following results:

First day	0.3192 gm. nitrogen.
Second “	0.2240 “ “
Third “	0.1092 “ “
Fourth “	0.1041 “ “
Fifth “	0.3032 “ “
Total in five days	1.0597 “ “
Average in one day	0.2119 “ “

The nitrogen in the food was	14.4305 gm.
“ “ feces “	1.8441 “
“ “ urine “	1.0597 “
Total loss through excretions was	2.903 “
Total retention was	11.527 “
The retention of the intake was	79.87 %

Whether these figures relating to the child's metabolism are wholly reliable or not cannot be said. Some studies of infants in the first few weeks of life have shown extremely high grades of nitrogen retention as compared with those that are observed in adults, even exceeding the retention shown by our figures in this case. This is natural because of the very rapid growth of their tissues at that period, but 79.8 per cent. of retention is so astonishingly high for an infant of the age of our subject that we cannot help suspecting that some of the child's urine was lost. If it was, we could not discover it, a careful watch having been kept on the apparatus regularly without any evidence of loss of urine at any time during the experiment. We do not feel, however, that the figures for metabolism can be further commented upon than to say that if they are correct they show most unusually favorable conditions, particularly for an atrophic infant. The figures for absorption are much poorer than those in the other children and are not very satisfactory. This was expected in this child, as he came in with a good deal of digestive disturbance, with about five movements daily, which were greenish and contained many curds. The bowels improved after his admission, but this study was begun soon after he came in, when there was still some digestive disturbance.

The further study that we made of metabolism and absorption was carried out in an adult patient, a subject of phthisis. This man had been on a very free diet, having had three meals a day and as large a quantity of milk and raw eggs in addition as he cared to take. He had been gaining quite rapidly in weight on this diet, and his general condition had improved. Because his previous diet had been a very heavy one, we put him, in both the preliminary and bean-flour periods, upon a very free diet as to quantity. In the preliminary period this consisted of milk 2400 c.c.; rice, 30 gm.; eggs, eight daily; bread, 300 gm.; butter, 60 gm.; sugar, 30 gm.; steak, 200 gm.; baked potato, 70 gm. In the bean-flour period the diet remained the same, excepting that the milk was reduced by 550 c.c. each day and in its place he was given each day a solution of predigested bean flour which contained 100 gm. of (dry) bean flour. The nitrogen in the food was estimated by weighing accurately each portion of the food and calculating the nitrogen from the weights. We have ourselves made a large number of nitrogen estimations of the bread, milk, butter, and steak used in the hospital in previous metabolism experiments that we have carried out, and we took the average of these figures for these foods. The nitrogen of the eggs and rice, which is very constant for a given weight, we took from the tables of König and Blyth. The nitrogen excreted in the urine was estimated daily. That of the feces was estimated in the total amount after the feces had been collected throughout the proper period, dried on the water bath (sulphuric acid having been added) and then ground fine. One detail of the work on the feces may be of some interest to investigators in this line. We have repeatedly had the experience, as we had in this instance, of finding that feces contained so much fat that it was impossible to grind them fine after drying them, or to get a homogeneous mixture by occasional stirring while they were drying. We have in some instances overcome this by extracting with alcohol and ether, then drying and grinding the residue and making nitrogen (and when desired, fat) estimations of both the residue and the alcohol and ether extracts. This burdensome procedure, however, proved unnecessary in this instance, and very good results in control estimations were obtained by first extracting with alcohol and ether, then grinding the residue fine after drying it, and then adding the alcohol and ether extracts again to the ground residue and evaporating as quickly as possible, with constant stirring so as to keep the mass thoroughly mixed. In this way a homogeneous mixture was obtained, and it could also be ground in a mortar much finer than it could before. Control estimations of the nitrogen corresponded very closely.

The results in this case were as follows:

PRELIMINARY PERIOD.

	Nitrogen in the Food.	Nitrogen in the Urine.
October 31	33.0347 gm.	25.4710 gm.
November 1	33.7943 "	23.1336 "
" 2	32.7100 "	22.1450 "
" 3	33.1116 "	21.0112 "
" 4	32.2051 "	25.5780 "
" 5	33.1345 "	18.8160 "
" 6	32.1041 "	21.1232 "
Total	230.0043 "	157 2780 "
Average	32.8577 "	22.4682 "

The total nitrogen in the feces in this period was 12.1866 gm.; the average daily excretion in the feces was 1.7409 gm. The combined urinary and fecal nitrogen in the whole period was 169.4646 gm.; and the daily average excretion was, therefore, 24.2092 gm. Since then the daily average in the food was 32.8577 gm., the average daily retention was 26.3 per cent. of the intake. The absorption of nitrogen was 93.7 per cent. of the intake.

BEAN-FLOUR PERIOD.

	Nitrogen in the Food.	Nitrogen in the Urine.
November 7	30.3704 gm.	22.3264 gm.
" 8	27.5247 "	17.1888 "
" 9	28.6844 "	23.7832 "
" 10	30.7284 "	21.7140 "
" 11	32.4540 "	18.2864 "
" 12	33.2469 "	22.9600 "
" 13	33.9411 "	17.3600 "
" 14	33 2166 "	29.9880 "
" 15	32.9460 "	21.7728 "
Total	283.1125 "	195.2796 "
Average	31.4569 "	21.6977 "

The nitrogen in the feces in this period was 17.0581 gm.; the daily average was 1.8953 gm. The combined urinary and fecal nitrogen was 212.3377 gm.; the daily average excretion was 23.5937 gm. The daily average in the food was 31.4569 gm. Hence, the average daily retention was 7.8639 gm. and the total retention was 70.7748 gm., which was 24.9 per cent. of the intake. The absorption in this period was 94.0 per cent. of the intake.

These figures for metabolism are, therefore, somewhat against the bean flour, since the retention, which was high in both periods, was about 1.5 per cent. better in the preliminary period than in the bean-flour period. The conditions in the early part of this experiment were, however, not satisfactory, for we met the same difficulty that has been noted many times before in attempts to administer legumes as ordinarily cooked, over a considerable period continuously; that is, after the first few portions, the man objected so greatly to the taste that it was almost impossible for him to take the beans. He made a willing effort to do so, however, and succeeded; but it upset his appetite so much that he was unable to take the proper amount of the other food, as is readily seen by referring to the table for the food nitrogen in the bean-flour period. These figures drop decidedly on the first day, and much more in the next two days; rising again on the next day, and reaching the proper point on the fifth day. The explanation of these figures lies in the point noted; in the first three days it was impossible by any of the means that we used to flavor the beans so as to make them agreeable. The rise in food nitrogen on the fifth day was coincident with the use of cinnamon as a flavor; this was agreeable to the man, and subsequently throughout the period of investigation and a long period afterward he took the predigested bean flour in his milk with entire satisfaction. The last five days of the experiment, therefore, offer a fairer comparison with the preliminary period than does the whole bean-flour period. The figures for these five days are as follows:

Average daily food nitrogen	33.1609	gm.
Average daily urinary nitrogen	22.0534	"
" " fecal "	1.8953	"
Total excretion daily	23.9487	"
Average retention (27.4 % of the intake) was	9.2122	"
Absorption of the intake was	94.2	%

The figures in this part of the bean-flour period are, therefore, 1 per cent. better as regards nitrogen retention than in the preliminary period, and almost 3 per cent. better than in the total bean-flour period. The figures for absorption in this period are very slightly below those in the preliminary period, but the figures for absorption in all three of these periods are so similar that they provide sufficient evidence that this man absorbed the bean nitrogen practically as well as the nitrogen from the milk, eggs, steak, and bread. All were absorbed very satisfactorily, particularly considering the very large food intake.

We cannot draw very definite conclusions from this experiment excepting to say that the bean proteid was quite as satisfactory as the other proteids in its influence upon metabolism. In the last part of the bean-flour period it seemed to have a slightly better effect upon metabolism than the other proteids, though the difference is so slight that little weight can be laid upon it. We could not expect much difference, however, even if nuclein has a noteworthy influence upon proteid metabolism as compared with the influence of other forms of proteid, for this man was already getting some animal nuclein in his food. The experiment serves chiefly to demonstrate the entire metabolic suitability of a large quantity of legumes in maintaining a large nitrogen retention, and also the satisfactory absorption of the proteid in the legume. The last result directly supports the view previously referred to concerning the absorption of vegetable proteid, and the results with metabolism also support the observations that have been made in considerable number, in adults, in regard to the influence of vegetable diet upon nitrogen metabolism, most such experiments having demonstrated the ready possibility of maintaining a nitrogen equilibrium and of sometimes producing a nitrogen retention, on a vegetable diet. This was usually done, however, by using vegetables cooked in the ordinary manner. The preparation that we used has the advantage of being an extremely concentrated food containing a very high energy value for its bulk and it is at the same time in fluid form. It is, therefore, in these points an excellent food for improving the nutritive condition when it is impossible to take a large bulk or to take solid or semisolid food in considerable quantities. The chief difficulty with it, and one that has as yet been hard for us to overcome, is the flavor, which is distasteful to most adults and older children from the beginning, or soon becomes so. Infants take it without trouble in practically all cases after one or two feedings, but it is difficult to persuade older children and adults to do so. Attempts to accomplish this become largely a question of flavoring, but when flavoring ingredients are necessary over a long period of time a great variety must be used or they too become distasteful. This limitation of the usefulness of this food in older persons may, therefore, remain permanent. The point cannot now be settled.

In infants, however, our clinical results up to the present have been such as to encourage us decidedly. We have not as yet used it in a very large series of cases, as our attention has been chiefly directed to the determination of its influence upon absorption and metabolism, and during this particular period of the year we have not had a large number of cases available for study. Those that have been studied are the following: nine in the service of Dr. Griffith at the University Hospital; five at the Seashore House at Atlantic City studied through the kindness of Dr. William H. Bennett; one private case of Dr. Charles H. Schoff. In these cases the gentlemen who had charge of the cases, or their assistants, usually the latter, prescribed the diet, excepting only that we suggested the amount of bean flour to be used. Another series, that could be studied for only a brief period, was seen at St. Christopher's Hospital. The results in the first fourteen cases, briefly abstracted, are as follows, first mentioning the least favorable cases:

CASE I.—J. P., aged five months; weight ten pounds nine ounces. Treated at Children's Seashore House, Atlantic City. Lost weight for ten days continuously, but slowly. Then weighed ten pounds four ounces. Had been on Meigs' mixture, then on partially peptonized milk. Was put on whey upon the appearance of decided acute digestive disturbance, in which the stools became green and contained mucus and curds and occasionally a trace of blood. This continued and he was put by one of the residents on three parts of Meigs' mixture and one part of 10 per cent. predigested bean flour, giving three ounces of this mixture every three hours. No noteworthy change occurred in his condition, and after ten days he was taken home, having lost in all one pound from the time of his admission. In our view this case was at this period an unsuitable one for this food or any other except the most dilute.

CASE II.—L. C., a girl aged ten months; weight nine and one-half pounds. Admitted to Children's Ward, University Hospital, with three or four greenish stools daily, containing curds. No acute disturbance. Put on barley-water for twenty-four hours. Then on a 3.6.1. mixture, three parts; 10 per cent. bean-flour solution, one part; five ounces being given every three hours.

The stools rapidly became normal and the child in ten days gained exactly a pound. At this time it developed fever, cyanosis, and rapid respirations. There was no digestive disturbance for five or six days after the onset of this acute illness, when a mild diarrhœa developed and the child one day vomited. The diet was then changed to a plain milk mixture without any noteworthy change in the condition of the digestion; the cyanosis and rapid respiration also continuing. This child died after continued illness. This case is mentioned among the unfavorable ones because one or two of those who saw the child thought that the bean flour was responsible for the acute illness. We personally felt that the attack was not originally a digestive one at all, but was probably due to an obscure bronchopneumonia. Autopsy showed numerous pyæmic abscesses of the lungs originating in middle-ear disease. This case cannot be used for or against the bean flour, though the child temporarily gained very rapidly on the mixture containing bean flour.

CASE III.—J. O., aged three months; weight eight pounds one ounce. Admitted with greenish stools containing curds; five movements daily. This child was the one mentioned as having been studied as to both absorption and metabolism. After one day of barley-water, the child was put on three parts of 4.6.2., one part of 10 per cent. bean-flour solution; why the diet was increased suddenly to this point is not recorded. In the next six days the child gained six ounces; it had never gained as much before. The bowel movements after the first two or three days became soft, yellow, and contained no curds, but there were three or four movements a day. In the following nine days he gained but one ounce more and the bowels were the same. On October 4th he had not gained further and the mother took him home. A more gradual increase in the food might have been more successful.

The others of the cases that were treated at the University Hospital and at Atlantic City are all more or less favorable. We will mention first the University Hospital cases and then the Atlantic City cases.

Case IV.—Girl, aged four months; weight six pounds thirteen and one-half ounces. This child was the second of our absorption studies. She was admitted having three or four movements a day; they were yellow, half-formed, contained a little mucus. She had lost weight gradually since birth, and had at no time gained; was extremely emaciated and weak. Upon admission she was put on barley-water, followed by Keller's malt-soup; after a week this was changed to a simple milk mixture, containing barley-jelly, which was afterward malted. As the bowels improved, the milk mixture was increased to a 4.7.2., containing malted barley-jelly. Throughout six weeks her weight had varied, with slight rises and falls, between six pounds thirteen ounces and seven pounds three ounces. Bean-flour solution was then added to the 4.7.2. mixture; her weight at this time being seven pounds three ounces. Six days later our bean flour gave out; at this time she weighed eight pounds. She continued gaining after this for four weeks, when she weighed nine and one-half pounds, a simple 4.7.2. mixture having been used during this time. She then lost half a pound in a week, and regained it only very gradually in the next three weeks. This was at the beginning of summer, and her slow gain was thought to be due to hot weather and "hospitalism," and she was sent to the seashore.

Case V.—The first of our absorption experiments. Was admitted with three to five stools daily that were greenish and loose. He was six months old; weighed six pounds fourteen ounces. He was much emaciated and weak. He was put on barley-water and then on weak milk mixture; gradually increased as the bowels soon became nearly normal to a 4.7.2., which was ordered eleven days after he was admitted. Eighteen days after admission his weight was six pounds fifteen ounces, there having been only slight fluctuation in this period. He was then given bean flour in the 4.7.2. mixture. Six days later, when the flour gave out, he weighed seven pounds fourteen ounces, the bowels remaining the same. Afterward, on a simple 4.7.2. mixture, he gained gradually, in five weeks, to nine and one-half pounds. He was then taken home in satisfactory condition and was lost sight of.

Case VI.—L. D., aged four months; weight six pounds; very weak. Admitted with mild digestive disturbance; three to five stools daily, which were yellow and partly formed, but contained some curds. Put on barley-water, then on dilute milk mixture, gradually increased. Five weeks after admission was given 4.7.2. mixture. The child was then having two or three movements a day, which were yellow and quite well digested, but there had been no gain. Six weeks after admission was given bean-flour solution in the 4.7.2. mixture. Four days later she weighed eight and one-half pounds. Was taken home just after this, weighing eight pounds nine and one-half ounces. Readmitted a week later with loose, greenish stools, and having lost half a pound; she had been on a simple milk mixture outside the hospital. Was put on barley-water, then on her previous milk mixture, and gained half a pound in five days. After this stayed stationary for a week and was then given bean-flour solution again, in her milk mixture, and gained a half-pound in four days, and a quarter of a pound in the next five days, and was again taken home in satisfactory condition, weighing nine and one-quarter pounds. The gain in this case when bean-flour solution was first given was almost incomprehensible. At each weighing before this time the record had been within an ounce or two of six pounds. At each weighing after five days of bean-flour solution the record was regularly above eight and one-half pounds. She was carefully weighed by the nurse, the resident physician, and by one of us, all records agreeing. The scales may have been at fault, but they were correct when tested afterward. If the gain was as recorded it was certainly not all due to increase of tissue, for in all her food during this time she received a little less than enough solids to have made this gain if all had been deposited in the form of tissue. Hence, some of it must have been retention of water. Water retention, however, is a very desirable thing in most atrophic infants, as their tissues are usually very abnormally dry. Whatever may be said of the weight records, the improvement in the child's condition was perfectly astonishing; within four days she became a wholly different-looking infant, and she retained her improvement.

Case VII.—Girl, aged thirteen months; weight eleven pounds, one ounce; very ill-nourished and weak. Admitted with five or six greenish stools daily, which contained mucus. Put on barley-water and then on a milk modification which was increased to 4.7.2. mixture, although the stools remained about the same. She gained a half-pound in the first ten days; then remained stationary for a week. Was then put on bean-flour solution. The bowels improved, but the movements still remained greenish and loose for a week, and in this time she lost a half-pound. From this period on, however, the bowels rapidly improved and soon became normal, and in the next three and one-half weeks she gained one and one-half pounds, and was discharged weighing one and one-half pounds more than when admitted, her bowels for two weeks having been entirely normal.

Case VIII.—C. B., girl, aged six months; admitted weighing seven and one-half pounds, with three or four greenish, half-formed movements daily. Put on barley-water for twenty-four hours, followed by simple milk modification. Bowels did not improve, and the child lost a half-pound in four days. Bean-flour solution was then added. The bowels within three days became normal, and in ten days the child gained slightly over a half-pound; in five days more another half-pound; in three days more another half-pound. Was discharged, with normal bowels, weighing eight and one-half pounds.

CASE IX.—D. L., boy, aged seven months. Admitted weighing nine pounds, with four or five movements daily, which were green and contained mucus and an occasional trace of blood. Put on barley-water, then on milk mixture; the bowels improved at first, but after three days remained stationary, continuing loose and greenish, with some mucus. Nine days after admission the child was on a 4.7.1. mixture; weighed nine and one-half pounds, but had been stationary for nearly a week. Then bean-flour solution was added; three days later the bowels were recorded as nearly normal, the child still weighed nine and one-half pounds. Six days later had gained a half-pound; four days later another half-pound; four days later than this another half-pound. Was discharged in satisfactory condition.

CASE X.—K. D., boy, aged nine months; weight twelve pounds; ill-nourished and weak. Three to five yellowish stools daily, containing curds. Put on barley-water and then on milk mixture, which was increased to 3.6.1. mixture and afterward up to 4.7.2. He had gained three ounces in five days. Wheat flour, predigested as the bean flour had been, was then added. The child gained four ounces in four days; then remained stationary for three days. Then predigested bean flour was substituted, and in the next three days there was a gain of nine ounces; in the next week four ounces; in the next week twelve ounces. Was discharged weighing fourteen pounds. The bowels had improved on the milk mixture and remained in good condition with the use of both wheat flour and bean flour.

The following four cases were treated at Atlantic City, by Dr. Wm. H. Bennett and Dr. Sidney Repplier:

CASE XI.—E. W., girl, aged seven months; weight fourteen pounds four ounces. Stools fairly normal; weight decreased regularly for a week, during which time she lost half a pound. At that time the bowels became loose, contained mucus, and were greenish. She had been on Meigs' mixture. To this was added, through a misunderstanding, over 4 per cent. of bean flour, with the result that vomiting occurred after every feeding. She was then put on peptonized milk and two days afterward was put back on Meigs' mixture containing 2½ per cent. of bean flour. Her weight was then thirteen pounds; stools greenish and contained mucus and curds. One week later had lost four ounces, but the stools were improved. Three days later gained two ounces, stools much improved. One week later gained five ounces, stools normal;

four days later gained five ounces more, stools normal. Was then taken home in good condition.

CASE XII.—Boy, aged five months; weight ten pounds eight ounces. Stools greenish and loose. Lost on Meigs' mixture six ounces in a week. Was then given 2½ per cent. bean flour in Meigs' mixture. Three days later stools much improved, had lost two ounces; three days later stools normal, had gained four ounces. Was then taken home by the mother.

CASE XIII.—A. E., aged seven months; weight twelve pounds; stools greenish, with curds. On Meigs' mixture, from July 1st to 26th, lost a pound. Bowels remained bad. Put, through misunderstanding as in the first case, on excessive amount of bean flour, getting over 6 per cent. Vomited occasionally for a day. Amount of bean flour reduced to 2½ per cent. Vomiting stopped at once, stools improved rapidly. Three days later stools normal excepting for a little mucus; had gained nine ounces; three days later had gained seven ounces more. Stools normal. Developed chickenpox and was sent home.

CASE XIV.—E. H., aged six months; weight eleven pounds four ounces; stools normal. Gained four ounces in a week; stools then became loose, and contained a little mucus. Lost six ounces in ten days. Had been on Meigs' mixture. Then bean-flour solution added. Gained four ounces in three days; stools improved. Gained ten ounces in the next five days; stools normal. Discharged in good condition.

In addition to these cases there were treated at St. Christopher's Hospital, in the service of one of us (Edsall), thirteen infants (Cases XV. to XXVII., inclusive), who for a short time got milk mixtures containing predigested wheat flour or predigested bean flour, the wheat flour having been used at first because bean flour could not be secured at that time. Unfortunately bean flour was obtained only a very short time before the term of duty on this service was ended, and hence these observations are of little value. They serve chiefly as a contrast between the effects of wheat flour in these cases and of bean flour in the cases that have already been detailed.

Of the thirteen cases, six were treated with mixtures containing predigested wheat flour, but got no bean flour, receiving the wheat flour in various cases for from ten days to three weeks. Five of these six lost persistently; one gained nicely from five pounds twelve ounces to six pounds twelve ounces in ten days, after having lost for the preceding ten days. The bowels in this case remained slightly loose. Three other infants got wheat flour for from ten days to two weeks, one gaining a few ounces at first and then losing, the others losing persistently. When bean flour was secured all these three were apparently near death, and all ultimately died; but upon the use of bean flour one held its weight for a week and then rapidly lost, while the others gained four ounces each in the first three days, and then died unexpectedly without any new symptoms. In all these cases the bean flour seemed to be well digested, and in all of them the bowel movements became more satisfactory under its use. Two other infants that had been on predigested wheat flour showed decided improvement of the bowels under bean flour, but were sent to the seashore in three days after its use without any record of their weight at the time. Another child had lost rapidly on predigested wheat flour and showed no gain on bean flour, though it held its weight for a week, when it suddenly died. It seemed *in extremis* when bean flour was started. Another child came in with a mild acute enterocolitis. It got barley-water for forty-eight hours, then whey, afterward whey and albumin-water alternating. The bowels remained persistently bad for a week, and the infant lost a pound. It was then given whey with 1½ per cent. of fat added and 2 per cent. predigested bean flour. The bowels became normal almost at once, and the infant gained a pound and a quarter in three days, and was taken home by its mother and lost sight of.

In none of these cases, excepting the last, was the child in a condition that permitted of any special hope from any treatment at the time that bean-flour solution was started. The results with wheat flour (that was given in almost the same form that Keller gives it in his malt-soup; though it was digested with another ferment) were very unsatisfactory in eleven out of twelve instances. One child, as stated, showed rapid improvement, but the others lost persistently, and no very satisfactory influence upon the bowels was observed; though in no instance did it seem to produce any further digestive disturbance. Hence, the results with wheat flour appear to be much less satisfactory than those with bean flour, though it is, of course, not wholly fair to contrast a group of cases in one institution with those in another. On the whole the St. Christopher's cases were more advanced when the wheat flour was started than were most of the cases at the University Hospital or at Atlantic City that were on bean flour; but in none of the cases at St. Christopher's Hospital was there any very recent acute disturbance of the digestive tract, excepting in the one last described. All the cases, including the last, were atrophic infants, their weights ranging from five and one-half to nine pounds. Three of the infants were under ten weeks of age; one of these was the infant that gained rapidly on wheat flour; the other two did not gain. One other was four months old, and the remainder were between six and eleven months of age.

In addition to atrophy in infants, we have thought that predigested legume flour might be of value in the management of cases in older children or in adults in which there is persistent digestive disturbance and difficulty in taking a sufficient amount of food, particularly proteid food; or in which there is malnutrition from other causes, and the food intake is unsatisfactorily low.

Our observations on this point have been as yet very fragmentary and we do not now feel extremely hopeful in regard to its practical usefulness in most of such cases unless some means of flavoring it satisfactorily can be devised; for, as stated, adults and older children object at once, or after taking a few portions, to the taste of the beans. The man on whom we did the metabolism experiment gained four pounds in the preliminary period (that in which no bean flour was used). In the first four days of the use of bean flour, when his appetite was much upset, and he took a much reduced amount of food, he lost two pounds; but in the next five days he gained three pounds, so that the gain in the first period and the last part of the bean-flour periods was practically the same. Afterward he went back to his usual diet and lost a pound a week for two weeks. He then requested that he be allowed to take predigested bean flour again. Without making any other change in the diet, he did this, and gained one pound each week for two weeks (the bean flour being then flavored), and his appetite improved together with his gain. The conditions in this case are hardly worthy of special comment, though rather favoring the bean flour.

In another case, however, very remarkable results were obtained, and this case is sufficient to encourage the further use of the preparation in children past infancy.

Case XXVIII.—A girl, aged two years, who in brief had the following history: She had been running down for a year; had had persistent digestive disturbance during this time, with constant diarrhœa and occasional vomiting, and nothing seemed to agree with her. She had constantly lost weight at the time when seen by Dr. Charles H. Schoff, of Media, who treated her with predigested bean flour. She had been for three months before this at Atlantic City, under the care of several skilful clinicians, and was then seen by Dr. J. P. Crozer Griffith, who tried a variety of diets without success. The child seemed entirely unable to take milk even when it was greatly diluted, and other liquids agreed but little better. She was then tried on semisolid and solid food, but grew decidedly worse. She was referred to Dr. Schoff at this time, and was then having from ten to fifteen bowel movements a day, which were loose and green. She was vomiting several times daily; was emaciated and extremely weak; her hands and feet were cold, and she was apparently in a desperate state. She weighed eighteen pounds. Several days of careful dieting and medication brought no improvement, and at our suggestion Dr. Schoff tried predigested bean-flour solution, alone, in small amounts. Finding that this did well it was rapidly increased, and the child was given eight ounces of 10 per cent. solution every three hours. Dr. Schoff states that within twenty-four hours the bowel movements were much reduced and much improved in appearance, and the vomiting had stopped. Within a few days more the bowel movements were reduced to about three daily and the child's general condition was greatly improved, and after this there was continuous general advance in health and improvement of the digestive tract. In the first week a gain of slightly less than a pound was made; in the second week a similar gain; in the third week a little over two pounds; in the fourth week two pounds. At this time it was attempted to give the child a very small amount of milk with the bean flour, but it immediately disturbed the digestion. Two weeks later other foods were gradually added, and the child when last heard from had continued to gain and was to all appearances perfectly normal excepting for a tendency to intestinal disturbance from slight causes. This child objected to the taste of the bean flour at first, but took the subsequent feedings readily.

In this case the usefulness of the preparation probably depended upon the fact that it is extremely easy of digestion, has a high nutritive value for its bulk, and contains (that which most other very easily digested preparations do not) an amount of proteid that is entirely sufficient for the needs of the organism. In similar cases, even when much less severe, it would be worthy of trial. It would also be worthy of trial (if agreeably flavored) in cases of acute infectious diseases, particularly in typhoid fever, when there is difficulty in digesting the proper amount of milk. In these cases the addition of a small amount of this preparation would increase the nutritive value of the food, and would sometimes improve the digestion—if in no other way, through its action upon the curd of the milk. It has become the custom of one of us, in a hospital service in which large numbers of cases of typhoid fever are seen, to treat any digestive disturbance on exactly the principles that are used in the treatment of digestive disturbances in infants, reducing the fats or the proteids or both as seems wise, and frequently adding a cereal to prevent the formation of large, tough curds. The latter is a particularly useful procedure in a certain number of cases, and we have seen it rapidly control serious disturbance of digestion, with diarrhœa, distention, etc., in typhoid cases. Predigested bean flour in the form in which we use it has, as we could readily determine, the same influence upon the curd as barley-jelly and the like, and it has also another influence—it is necessary to add much more acid to milk to curdle it when predigested bean flour is present than when it is not. This is probably due to the acid combining with the proteid of the bean.

These clinical results seem to us on the whole to be decidedly favorable. It is to be remembered that all the infants treated were hospital babies, and that with one exception (the last St. Christopher's Hospital case) they had all been losing before the bean flour was started, or had at best merely maintained a very low weight. We would also have it especially noted that no change was made in the diet excepting that a portion of what the infants had been getting immediately before was cast out, and in its place an equivalent, or usually very slightly less, value of bean flour was given. All the St. Christopher's Hospital cases, excepting the last, are of little importance, since all were in extremely bad condition when the bean flour was started, and only three of them got this preparation as long as a week. These three did a little better than they had done for some time before, though they all died. Of the cases treated elsewhere, three have been classed as unfavorable. The first of these was at the time probably not in condition to receive this or any other food, except the most dilute, and hence was certainly not a suitable case for trial of the food. In the second case there was a rapid gain at first, and then an acute illness which was not due to the diet. In the third case there was some gain, though on the whole the infant did not do well; but the milk mixture used was certainly very concentrated for an infant of the age and digestion of this one, and a lower modification might have done better. In none of these instances was there any actual evidence that the food did harm. The other infants all gained and all were continuously improving when they passed from observation, most of them having increased largely and rapidly in weight and strength and many of them having much improved digestions. Eleven out of fourteen infants, therefore, showed decided improvement, and most of them showed very striking improvement.

Atrophic infants, when treated in hospitals, certainly do not usually show so high a percentage of improvement and such large gains. Indeed, in our experience, and certainly in that of most other observers, such cases are, in hospitals, most unsatisfactory to treat, and usually show persistent downward progress. We think, therefore, that there is good reason to encourage a more extensive trial of the preparation.

There are, of course, several evident reasons why one may be doubtful whether the legume flour had any influence in these cases that was peculiar to itself. The readiest objection that could be raised we have already met—the improvement was certainly not due merely to increase in the amount of food, for the amount of bean flour was purposely kept only equal to or a very little below the amount of milk mixture that it displaced. Those who use very low modifications may consider that some of the infants, at least, had had too strong a milk mixture previously, and that the improvement was due to dilution of the milk. There may be some truth in this; for some of the milk mixture was displaced by the bean-flour solution, and there was, therefore, a little dilution of the milk, but if this is the explanation of the results it means that these babies digested and absorbed the bean-flour solution better than they did modified milk, for the food as a whole was not appreciably diluted, the bean flour, as stated, maintaining the actual concentration of the total food at practically the previous point. Another possibility that might be suggested is that improvement did not occur because of any influence of bean flour as such, but merely because of its mechanical effect on the curd. This is almost certainly not the case, for most of the babies had already received either barley-water, barley-jelly, malted barley-jelly, predigested wheat flour, or arrowroot.

Three points are, however, subject to somewhat serious criticism. In the first place the number of cases is small, and a larger number may show that our results were due simply to chance good fortune. Again, our cases were necessarily under observation for but short periods, and longer observation is necessary before it can be stated whether infants can often be brought back to good health by this means. Further, we have suggested that the bean flour probably exercised a special influence directly upon metabolism; that is, that it did not act solely through its influence upon digestion, or through the fact that an increased amount of food was being absorbed by babies who had previously been unable to take enough. This we have not definitely proved, but in support of our suggestion we have the following facts: While it is true that in most instances the digestion was more or less decidedly improved under the use of bean-flour solution when there was previously distinct digestive disturbance, it is equally noteworthy that in a number of instances the digestion was but little disturbed beforehand. In most instances also the gain in weight and strength was almost immediate, and it was usually very rapid, while the digestion in repeated instances improved only much more gradually; so that it appeared in such cases that the improvement of digestion was a part of the general improvement rather than the cause of it. Further, and most important, there was in some instances little or no change in digestion, and yet very marked improvement occurred; for example, in the first two cases in which absorption was studied the bowel movements of the two periods remained about the same, and the figures show that the actual absorption was already good and practically did not change when bean flour was given, yet both infants gained nearly a pound in six days, and afterward continued to gain while they had previously been stationary. That this food is capable of causing much improvement of digestion was shown by a number of the cases, most strikingly by Dr. Schoff's very remarkable case in the two-year-old child, in which the result was probably due chiefly to the influence on digestion. Disturbance of digestion, however, does not constitute the whole of the pathology of infancy. In dealing with adults there is an increasing and proper conviction that a good deal more digestive disturbance than was once thought is dependent upon some general disorder of nutrition; that is, that the disorder of digestion is not the primary condition, but is itself a result of some other disease; and the fact that digestive disturbance is of enormous importance in infancy and early childhood need not, as it often does, render obscure the similarly important fact that in not a few instances in infants also the most important disturbance is one of general nutritive processes rather than of the digestive organs.

In order to give satisfactory evidence that the successful results in our cases were due to a special influence of the bean flour, and, particularly, to a special influence of the bean proteid, we must, however, demonstrate that similar results cannot be obtained in a similar proportion of cases by means of predigested starches of other forms. To a limited extent we have given evidence of this in the cases so far studied. One infant had been on Keller's malt-soup, and also on malted barley-jelly, with no improvement; another infant was treated with predigested wheat flour with slight improvement, then became stationary, and immediately afterward gained rapidly, as long as it was under observation, when we used bean flour. The cases seen at St. Christopher's Hospital also favor somewhat the view that wheat flour produces less successful results than bean flour.

If legume flour has this special influence upon the metabolism of atrophic infants, we think it may most readily be thought that it is due to the effect of the nuclein, or possibly to other particular substances in the flour, but not to the mere gross quantity of proteid in it, for the actual amount of proteid absorbed, as seen in the experiments detailed, was almost the same when bean flour was being used and when it was not.

SUMMARY. Bean flour in which the starch is predigested by means of a diastatic ferment seems to be well digested and absorbed by infants and adults. An extremely concentrated food may be given in this way in fluid and partially digested form; a 20 per cent. solution, although fluid, is practically equivalent to beefsteak in nutritive value. Its influence upon the digestive tract in infants in the cases studied was usually distinctly favorable, and its influence upon metabolism in infants and adults is at least equal to that of milk. Of fifteen infants treated, one did not gain; one gained rapidly, but had an intercurrent illness and the flour was stopped; one gained nine ounces and then almost ceased to gain. The others gained as follows: one, fifteen ounces in six days; one, thirteen ounces in six days, both continuing after the bean flour gave out; one, one and a half pounds in sixteen days; one, one and a half pounds in twenty-three days; one, one and a half pounds in seventeen days; one, over two pounds in four days, and after readmission twelve ounces in eleven days; one, one and a half pounds in twenty days; one, twelve ounces in eleven days; one, four ounces in three days (then taken home); one, one pound in seven days; one, one pound in eight days; one, one and one-half pounds in three days. All these were atrophic infants that had previously been stationary or losing. A child of two years that had had persistent and very dangerous disturbance of digestion with advanced malnutrition improved immediately, the digestive tract became nearly normal within a few days, and the child repeatedly gained over two pounds a week. The last-mentioned child took nothing but bean-flour solution; the infants took usually about 2½ per cent. of bean flour in milk modifications.

These results are certainly unusual. They need to be controlled in several ways before any definite conclusions can be drawn from them, but it seems possible that they were due to a special influence of the legume flour on metabolism, and, perhaps, to a particular influence of the nuclein contained in this flour upon the tissue-building processes.

One point that appears to be of some importance we have definitely determined: it is easily possible to administer in this way as much as 0.75 per cent. to 1.0 per cent. of proteid, a fact of decided consequence in those common cases in which it is difficult or impossible to administer a proper amount of milk proteid.

It is desirable to test this preparation further in older children and adults who are the subjects of malnutrition. This will necessitate, however, some method of preparing the bean-flour solution by which it can be pleasantly flavored, as when unflavored its taste prevents its use with older patients for any considerable period. Infants, however, take it readily in milk.

THREE CASES OF POISONING BY POTASSIUM CYANIDE.

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Cases of poisoning by cyanide of potassium are not frequent in this country, being met with more frequently in England, Germany, and France. The drug is usually taken with suicidal intent; thus, in 402 cases of cyanic poisoning collected by Witthaus[1] in 65.4 per cent. of cases the poison was taken for this purpose. Of this number cyanide of potassium was the drug used in 83 cases. Of the 256 suicides, but 43 were women, and of those who took cyanide of potassium 5 were relatives of photographers and 4 of platers. This fact is of interest, as the majority of cases reported occur among photographers, electroplaters, mirror-makers, chemists, and soldiers, their occupations rendering the procuring of the drug comparatively easy.

I am indebted to Dr. John D. Curran, of Binghamton, New